



New Jersey Department of Environmental Protection  
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Water Monitoring Project  
Water Monitoring Management

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REAPPRASAL OF

SHELLFISH GROWING AREA (SUNSET LAKE TO CAPE  
MAY HARBOR)

WILDWOOD TO CAPE MAY CITY

1992 - 1998

Water Monitoring Report Prepared by:

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GOVERNOR**

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1992-1998**



New Jersey Department of Environmental Protection  
ROBERT C. SHINN, Jr.  
COMMISSIONER

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## ***EXECUTIVE SUMMARY***

This report is a reappraisal that contains water quality data for growing area (Sunset Lake to Cape May Harbor). This report evaluates data collected between January 1, 1992 and June 12, 1998. The water quality information was consistent and met the criteria for the current classifications of *Special Restricted* and *Prohibited*. However, establishment of additional sampling stations is recommended as well as establishment of stations designated for coliphage sampling in order to obtain a greater amount of recent data to make an evaluation.

## ***INTRODUCTION***

### **PURPOSE**

This report is part of a series of studies having a dual purpose. The first and primary purpose is to comply with the guidelines of the National Shellfish Sanitation Program (NSSP) that are established by the Interstate Shellfish Sanitation Conference (ISSC). Reports generated under this program form the basis for classifying shellfish waters for the purpose of harvesting shellfish for human consumption. As such, they provide a critical link in protecting human health.

The second purpose is to provide input to the State Water Quality Inventory Report, which is prepared pursuant to Section 305(b) of the Federal Clean Water Act (P.L. 95-217). The information contained in the growing area reports is used for the New Jersey State Water Quality Inventory Report (305b) which provides an assessment to Congress every two years of current water quality conditions in the State's major rivers, lakes, estuaries, and ocean waters. The reports provide valuable information for the 305(b) report, which describes the waters that are attaining state designated water uses and national clean water goals; the pollution problems identified in surface waters; and the actual or potential sources of pollution. Similarly, the reports utilize relevant information contained in the 305(b) report, since the latter assessments are based on instream monitoring data (temperature, oxygen, pH, total and fecal coliform bacteria, nutrients, solids, ammonia and metals), land-use profiles, drainage basin characteristics and other pollution source information.

From the perspective of the Shellfish Classification Program, the reciprocal use of water quality information from reports represent two sides of the same coin: the growing area report focuses on the estuary itself, while the 305(b) report describes the watershed that drains to that estuary.

The Department participates in a cooperative National Environmental Performance Partnership System (NEPPS) with the USEPA which emphasizes ongoing evaluation of issues associated with environmental regulation, including assessing impacts on waterbodies and measuring improvements in various indicators of environmental health.

The shellfish growing area reports are intended to provide a brief assessment of the growing area, with particular emphasis on those factors that affect the quantity and quality of the shellfish resource. As the Department implements a comprehensive watershed management program in conjunction with the NEPPS initiative, the shellfish growing area reports provide valuable information on the overall quality of the saline waters in the most downstream sections of each major watershed. In addition, the reports assess the quality of the biological resource and provide a reliable indicator of potential areas of concern and/or areas where additional information is needed to accurately assess watershed dynamics.

## **HISTORY**

As a brief history, the NSSP developed from public health principles and program controls formulated at the original conference on shellfish sanitation called by the Surgeon General of the United States Public Health Service in 1925. This conference was called after oysters were implicated in causing over 1500 cases of typhoid fever and 150 deaths in 1924. The tripartite cooperative program (federal, state and shellfish industry) has updated the program procedures and guidelines through workshops held periodically until 1977. Because of concern by many states that the NSSP guidelines were not being enforced uniformly, a delegation of state shellfish officials from 22 states met in 1982 in Annapolis, Maryland, and formed the ISSC. The first annual meeting was held in 1983 and continues to meet annually at various locations throughout the United States.

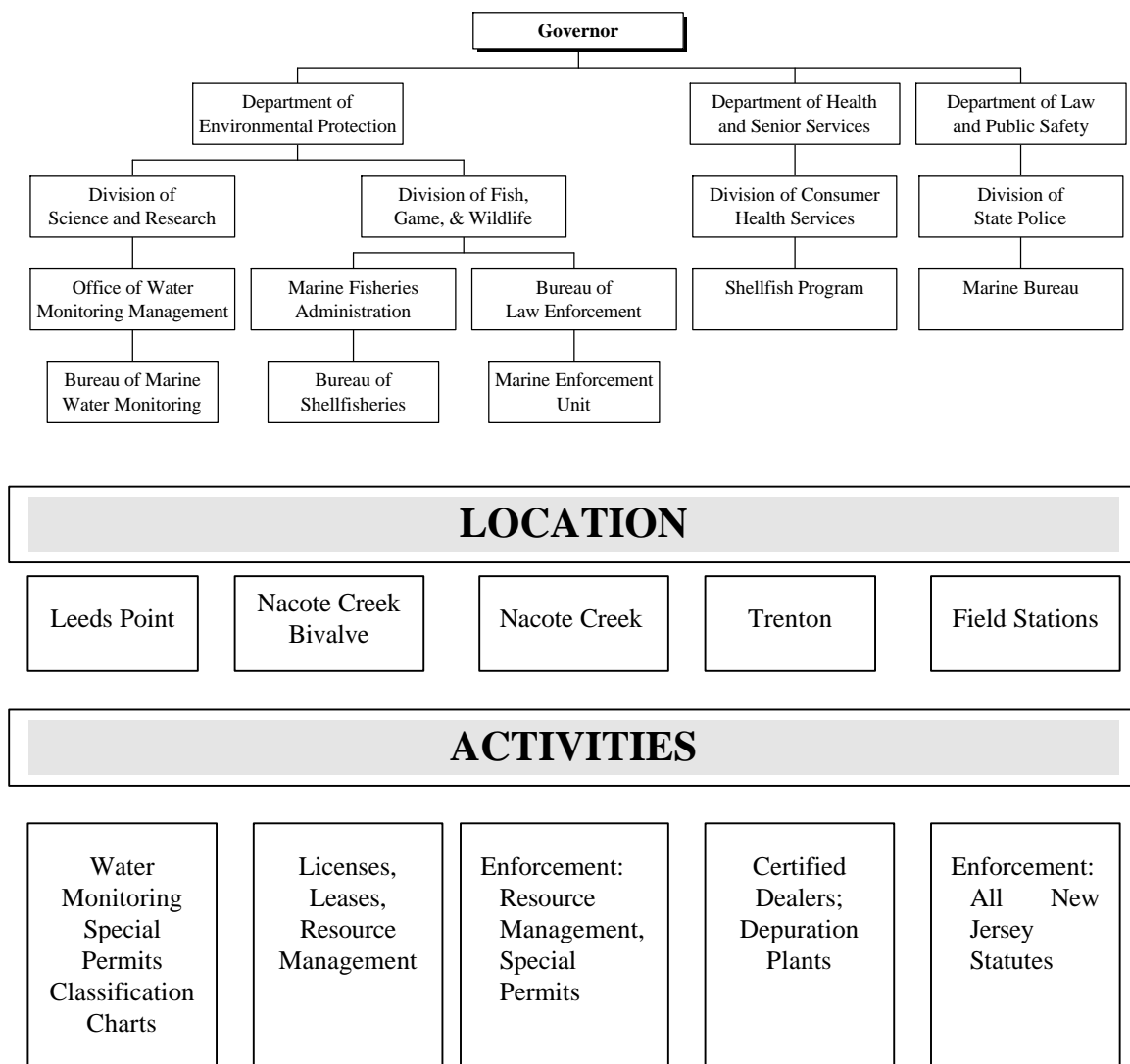
Parts I and II of the NSSP Manual set forth the principles and requirements for the sanitary control of shellfish produced and shipped in interstate commerce in the United States. They provide basis used by the Federal Food and Drug Administration (FDA) in evaluating state shellfish sanitation programs. There are five major points on which the state is evaluated by the FDA include:

1. The classification of all actual and potential shellfish growing areas as to their suitability for shellfish harvesting.
2. The control of the harvesting of shellfish from areas that are classified as restricted, prohibited or otherwise closed.
3. The regulation and supervision of shellfish resource recovery programs.
4. The ability to restrict the harvest of shellfish from areas in a public health emergency, and
5. Prevent the sale, shipment or possession of shellfish that cannot be identified as being produced in accordance with the NSSP and have the ability to condemn, seize or embargo such shellfish.

## **FUNCTIONAL AUTHORITY**

The authority to carry out these functions is divided between the Department of Environmental Protection (DEP), the Department of Health and Senior Services and the Department of Law and Public Safety. The Bureau of Marine Water Monitoring (BMWM) under the authority of N.J.S.A. 58:24 classifies the shellfish growing waters and administers the special resource recovery programs. Regulations delineating the growing areas are promulgated at N.J.A.C. 7:12 and are revised annually. Special Permit rules are also found at N.J.A.C. 7:12 and are revised as necessary.

**Figure 1: State of New Jersey Shellfish Agencies**



The Bureau of Shellfisheries in the Division of Fish, Game and Wildlife issues harvesting licenses and leases for shellfish grounds under the Authority of N.J.S.A. 50:2 and N.J.A.C. 7:25. This bureau in conjunction with the BMWWM administers the Hard Clam Relay Program.

The Bureau of Law Enforcement in the DEP (Division of Fish, Game, and Wildlife) and the Division of State Police in the Department of Law and Public Safety enforce the provisions of the statutes and rules mentioned above.

The Department of Health is responsible for the certification of wholesale shellfish establishments and in conjunction with the BMWWM, administers the depuration program.

### **IMPORTANCE OF SANITARY CONTROL OF SHELLFISH**

Emphasis is placed on the sanitary control of shellfish because of the direct relationship between pollution of shellfish growing areas and the transmission of diseases to humans. Shellfish borne infectious diseases are generally transmitted via a fecal-oral route. The pathway is complex and quite circuitous. The cycle usually begins with fecal contamination of the shellfish growing waters. Sources of such contamination are many and varied. Contamination reaches the waterways via runoff and direct discharges.

Clams, oysters and mussels pump large quantities of water through their bodies during the normal feeding process. During this process the shellfish also concentrate microorganisms, which may include pathogenic microbes, and toxic heavy metals/chemicals. It is imperative that a system is in place to reduce the human health risk of consuming shellfish from areas of contamination.

Accurate classifications of shellfish growing areas are completed through a comprehensive sanitary survey. The principal components of the sanitary survey report include:

1. An evaluation of all actual and potential sources of pollution,
2. An evaluation of the hydrography of the area and
3. An assessment of water quality. Complete intensive sanitary surveys are conducted every 12 years with interim narrative evaluations completed on a three-year basis. If major changes to the shoreline or bacterial quality occur, then the intensive report is initiated prior to its 12 year schedule.

The following narrative constitutes this bureau's assessment of the above mentioned components and determines the current classification of the shellfish growing waters.

## ***DESCRIPTION***

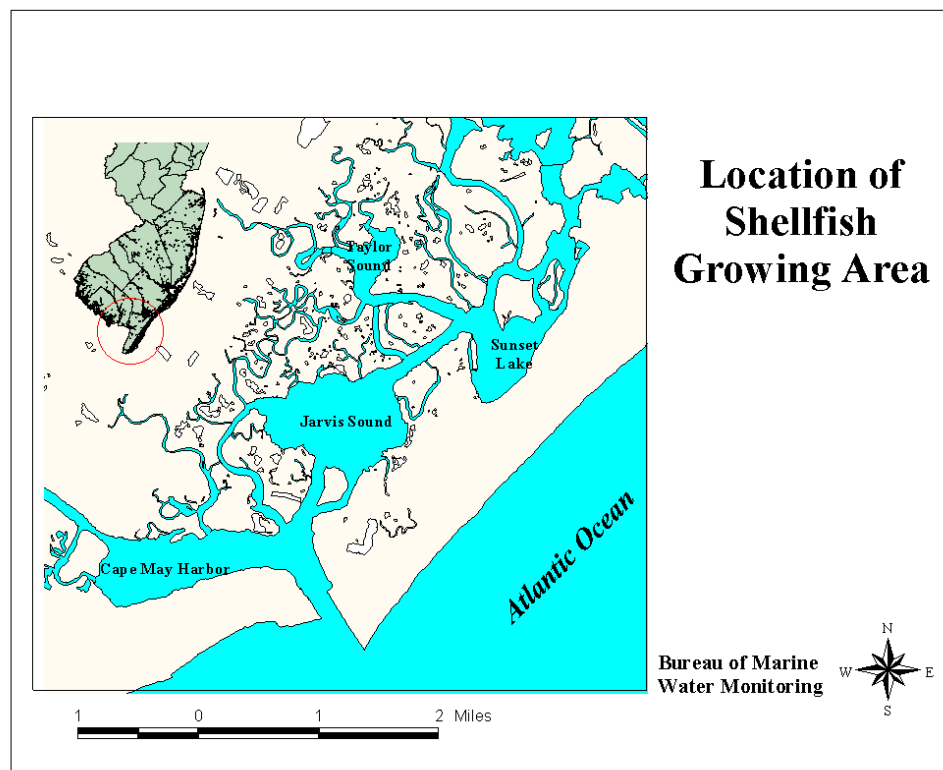
### **DESCRIPTION**

The growing area that encompasses Sunset Lake to Cape May Harbor is located in Lower Township, Cape May County and includes the estuarine or back-bay waters from Wildwood to Cape May City (including Cape May Harbor, Cape May Canal and Cape May Inlet). This area can be found on chart 9 of the “State of New Jersey - Shellfish Growing Water Classification Charts - 1998”. Shallow bays (sounds) and deeper connecting channels characterize the back-bay area. Tidal flushing of the area occurs mainly through the Cape May Inlet with some flow through the Cape May Canal.

The northern boundary of this area follows State Highway Route 47 (Rio Grande Boulevard). The western boundary follows the Garden State Parkway and the eastern boundary is the Atlantic Ocean. The municipalities located within this area include Wildwood City, Wildwood Crest and Cape May City. Population statistics for these municipalities are shown in Table I. It should be noted that Wildwood City is partially located in another growing area. In addition, population statistics for North Wildwood were included for comparison.

### **LOCATION**

**Figure 2: Location of Shellfish Growing Area**



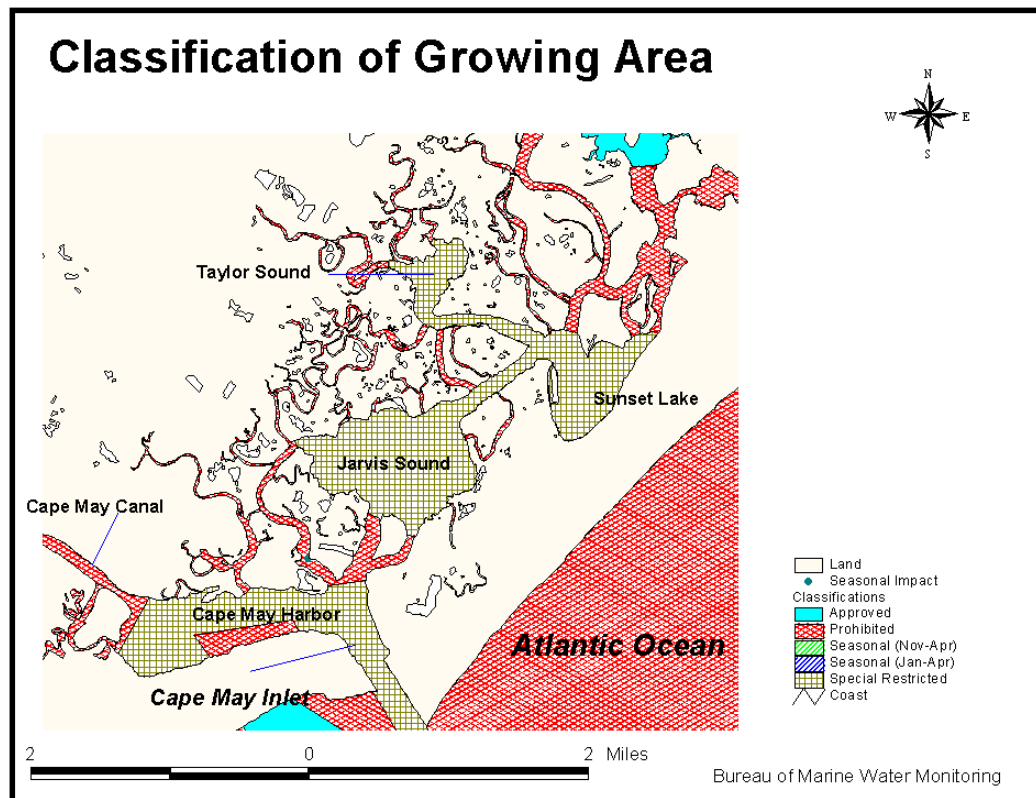
**Table 1: Population Statistics for the area**

MUNICIPALITY	POPULATION		AREA SQ.MI.	POPULATION DENSITY (persons/sq. mi.)	
	Year-Round	Summer		Year-Round	Summer
North Wildwood	5,067	75,000	1.7	2,981	44,118
Wildwood City	4,484	250,000	1.5	2,989	166,667
Wildwood Crest	3,631	100,000	1.0	3,631	100,000
Cape May City	4,934	30,880	2.24	2,202	13,786

## **HISTORY**

The Shellfish waters of this area are all classified as *Special Restricted* waters or *Prohibited*. The *Special Restricted* classification applies to waters of Taylor Sound, Jarvis Sound, Swain Channel, Sunset Lake and portions of the Cape May Harbor area. The remaining estuarine waters are classified as *Prohibited*. The *Special Restricted* classification signifies that harvesting of shellfish for direct marketing from these waters is

**Figure 3: Growing Area's Classification**



*Prohibited*. The harvesting of shellfish from these *Special Restricted* waters is allowed only under a special permit issued in compliance with the State's relay or depuration programs. The last time these waters were harvested was in 1995. The lack of activity in this area is not due to a lack of shellfish resources, but to a lack of interest shown by the baymen in requesting a special harvest of the area through the shellfish council. Prior to 1970, all of the estuarine waters of this area were classified as *Prohibited*. In 1970 sections of the area were upgraded or reclassified to *Special Restricted* waters based on water quality criteria. As depicted in the report Shellfish Survey-Shellfish Growing Area SE-6, Cape May Harbor and Jarvis Sound, 1989-1993, data from 1988 through 1993 showed the following:

1. Very few stations failed to meet *Special Restricted* classification.
2. Many stations failed to meet *Approved* classification.
3. This growing area was correctly classified.

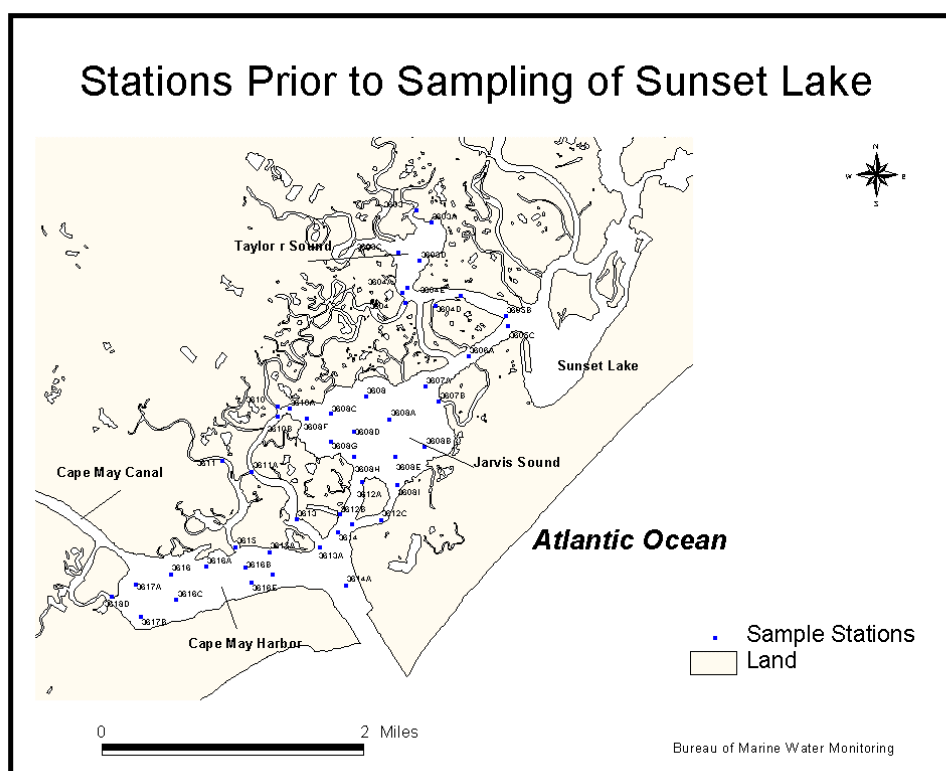
The 1993 report also included the last Sanitary Survey completed for this area.

Due to budget constraints of FY 1993 the Bureau removed several stations located in the *Prohibited* waters of Sunset Lake from the sampling schedule (See Figure 4). The Atlantic Coast Shellfish Council then requested a review of the classification of the *Prohibited* waters of Sunset Lake. As a result of the Council's request, a special sampling run was established (Assignment 278) for the 1995-1996 sampling season. Therefore, two sampling assignments (Assignments 277 and 278) represented this area during the 1995-1996 sampling season. Both sampling assignments used the Adverse Pollution Condition Strategy. For the 1996-1997 sampling season an assignment was established to consolidate both Assignment 277 and 278, thus eliminating the need for two sampling runs. This assignment is now known as Assignment 277 (see Figure 5).

In October 1996 a reevaluation of this area was done and a report was written, (Shellfish Survey Shellfish Growing Area SE-6, Sunset Lake to Cape May Harbor, 1988-1996). Data from 1988 to 1996 showed a marked improvement in the water quality of Sunset Lake. Therefore, a tract of 325 acres was upgraded and reclassified from *Prohibited* to *Special Restricted*. Lower, Middle and Upper Thorofare also met the criteria for *Special Restricted* classification. However, since the area supports many boating activities - which can significantly increase the possibility of pollution - the waters will remain classified as *Prohibited*. The areas that are located in Cape May Harbor also will remain classified as *Prohibited*, since the Coast Guard Training Facility and numerous marinas impact these areas.

Since the reevaluation in 1996, this area has continued to be sampled under Assignment 277. However, the sampling strategy was changed from using the Adverse Pollution Condition (rainfall priority) to Systematic Random Sampling for the 1997 - 1998 sampling years. The Annual report for data year 1997 indicated that the waters of Sunset Lake were meeting the *Approved* criteria. However, this was based on less than the required number of sampling runs. The number of sampling runs were increased from 6 to 15 during the 1997-1998 sampling season to provide the additional data needed to properly assess the water quality in this area. Also, in Jarvis Sound five stations were established for coliphage sampling (3607A, 3608C, 3608E, 3608G, and 3608I). These stations were selected since they have had high coliform counts in the past with no obvious direct source of pollution. Therefore microbial indicators differentially detect and quantify human

**Figure 4: Stations Prior to sampling of Sunset Lake.**



and non-human fecal wastes in waters and molluscan shellfish. Coliphage are viruses that infect coliforms and have been proposed as fecal contamination indicators because they are present in human and animal feces and in sewage.

# Sampling Stations

This map illustrates the sampling stations and shellfish waters in Cape May Harbor and the surrounding region. The map includes the following features:

- Geographic Labels:** Taylor Sound, Cape May Canal, Cape May Harbor, Cape May Inlet, Jarvis Sound, Sunset Lake, and Atlantic Ocean.
- Sampling Stations:** Indicated by green dots with alphanumeric codes (e.g., 3601E, 3602, 3602B, 3602C, 3603A, 3603B, 3603C, 3603D, 3603E, 3603F, 3603G, 3603H, 3603I, 3603J, 3603K, 3603L, 3603M, 3603N, 3603O, 3603P, 3603Q, 3603R, 3603S, 3603T, 3603U, 3603V, 3603W, 3603X, 3603Y, 3603Z, 3604A, 3604B, 3604C, 3604D, 3604E, 3604F, 3604G, 3604H, 3604I, 3604J, 3604K, 3604L, 3604M, 3604N, 3604O, 3604P, 3604Q, 3604R, 3604S, 3604T, 3604U, 3604V, 3604W, 3604X, 3604Y, 3604Z, 3605A, 3605B, 3605C, 3605D, 3605E, 3605F, 3605G, 3605H, 3605I, 3605J, 3605K, 3605L, 3605M, 3605N, 3605O, 3605P, 3605Q, 3605R, 3605S, 3605T, 3605U, 3605V, 3605W, 3605X, 3605Y, 3605Z, 3606A, 3606B, 3606C, 3606D, 3606E, 3606F, 3606G, 3606H, 3606I, 3606J, 3606K, 3606L, 3606M, 3606N, 3606O, 3606P, 3606Q, 3606R, 3606S, 3606T, 3606U, 3606V, 3606W, 3606X, 3606Y, 3606Z, 3607A, 3607B, 3607C, 3607D, 3607E, 3607F, 3607G, 3607H, 3607I, 3607J, 3607K, 3607L, 3607M, 3607N, 3607O, 3607P, 3607Q, 3607R, 3607S, 3607T, 3607U, 3607V, 3607W, 3607X, 3607Y, 3607Z, 3608A, 3608B, 3608C, 3608D, 3608E, 3608F, 3608G, 3608H, 3608I, 3608J, 3608K, 3608L, 3608M, 3608N, 3608O, 3608P, 3608Q, 3608R, 3608S, 3608T, 3608U, 3608V, 3608W, 3608X, 3608Y, 3608Z, 3609A, 3609B, 3609C, 3609D, 3609E, 3609F, 3609G, 3609H, 3609I, 3609J, 3609K, 3609L, 3609M, 3609N, 3609O, 3609P, 3609Q, 3609R, 3609S, 3609T, 3609U, 3609V, 3609W, 3609X, 3609Y, 3609Z, 3610A, 3610B, 3610C, 3610D, 3610E, 3610F, 3610G, 3610H, 3610I, 3610J, 3610K, 3610L, 3610M, 3610N, 3610O, 3610P, 3610Q, 3610R, 3610S, 3610T, 3610U, 3610V, 3610W, 3610X, 3610Y, 3610Z, 3611A, 3611B, 3611C, 3611D, 3611E, 3611F, 3611G, 3611H, 3611I, 3611J, 3611K, 3611L, 3611M, 3611N, 3611O, 3611P, 3611Q, 3611R, 3611S, 3611T, 3611U, 3611V, 3611W, 3611X, 3611Y, 3611Z, 3612A, 3612B, 3612C, 3612D, 3612E, 3612F, 3612G, 3612H, 3612I, 3612J, 3612K, 3612L, 3612M, 3612N, 3612O, 3612P, 3612Q, 3612R, 3612S, 3612T, 3612U, 3612V, 3612W, 3612X, 3612Y, 3612Z, 3613A, 3613B, 3613C, 3613D, 3613E, 3613F, 3613G, 3613H, 3613I, 3613J, 3613K, 3613L, 3613M, 3613N, 3613O, 3613P, 3613Q, 3613R, 3613S, 3613T, 3613U, 3613V, 3613W, 3613X, 3613Y, 3613Z, 3614A, 3614B, 3614C, 3614D, 3614E, 3614F, 3614G, 3614H, 3614I, 3614J, 3614K, 3614L, 3614M, 3614N, 3614O, 3614P, 3614Q, 3614R, 3614S, 3614T, 3614U, 3614V, 3614W, 3614X, 3614Y, 3614Z, 3615A, 3615B, 3615C, 3615D, 3615E, 3615F, 3615G, 3615H, 3615I, 3615J, 3615K, 3615L, 3615M, 3615N, 3615O, 3615P, 3615Q, 3615R, 3615S, 3615T, 3615U, 3615V, 3615W, 3615X, 3615Y, 3615Z, 3616A, 3616B, 3616C, 3616D, 3616E, 3616F, 3616G, 3616H, 3616I, 3616J, 3616K, 3616L, 3616M, 3616N, 3616O, 3616P, 3616Q, 3616R, 3616S, 3616T, 3616U, 3616V, 3616W, 3616X, 3616Y, 3616Z, 3617A, 3617B, 3617C, 3617D, 3617E, 3617F, 3617G, 3617H, 3617I, 3617J, 3617K, 3617L, 3617M, 3617N, 3617O, 3617P, 3617Q, 3617R, 3617S, 3617T, 3617U, 3617V, 3617W, 3617X, 3617Y, 3617Z, 3618A, 3618B, 3618C, 3618D, 3618E, 3618F, 3618G, 3618H, 3618I, 3618J, 3618K, 3618L, 3618M, 3618N, 3618O, 3618P, 3618Q, 3618R, 3618S, 3618T, 3618U, 3618V, 3618W, 3618X, 3618Y, 3618Z, 3619A, 3619B, 3619C, 3619D, 3619E, 3619F, 3619G, 3619H, 3619I, 3619J, 3619K, 3619L, 3619M, 3619N, 3619O, 3619P, 3619Q, 3619R, 3619S, 3619T, 3619U, 3619V, 3619W, 3619X, 3619Y, 3619Z, 3620A, 3620B, 3620C, 3620D, 3620E, 3620F, 3620G, 3620H, 3620I, 3620J, 3620K, 3620L, 3620M, 3620N, 3620O, 3620P, 3620Q, 3620R, 3620S, 3620T, 3620U, 3620V, 3620W, 3620X, 3620Y, 3620Z, 3621A, 3621B, 3621C, 3621D, 3621E, 3621F, 3621G, 3621H, 3621I, 3621J, 3621K, 3621L, 3621M, 3621N, 3621O, 3621P, 3621Q, 3621R, 3621S, 3621T, 3621U, 3621V, 3621W, 3621X, 3621Y, 3621Z, 3622A, 3622B, 3622C, 3622D, 3622E, 3622F, 3622G, 3622H, 3622I, 3622J, 3622K, 3622L, 3622M, 3622N, 3622O, 3622P, 3622Q, 3622R, 3622S, 3622T, 3622U, 3622V, 3622W, 3622X, 3622Y, 3622Z, 3623A, 3623B, 3623C, 3623D, 3623E, 3623F, 3623G, 3623H, 3623I, 3623J, 3623K, 3623L, 3623M, 3623N, 3623O, 3623P, 3623Q, 3623R, 3623S, 3623T, 3623U, 3623V, 3623W, 3623X, 3623Y, 3623Z, 3624A, 3624B, 3624C, 3624D, 3624E, 3624F, 3624G, 3624H, 3624I, 3624J, 3624K, 3624L, 3624M, 3624N, 3624O, 3624P, 3624Q, 3624R, 3

Water sampling was performed in accordance with the Field Procedures Manual (NJDEP, 1992).

Water quality sampling, shoreline and watershed surveys were conducted in accordance with the Guide for the Control of Molluscan Shellfish, Part IV, Shellstock Growing Areas (USPHS, 1997-Revision).

## **BACTERIOLOGICAL INVESTIGATION AND DATA ANALYSIS**

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for the Control of Molluscan Shellfish, Part IV, Shellstock Growing Areas (USPHS, 1997-Revision). Each shellfish producing state is directed to adopt either the total coliform criterion, or the fecal coliform criterion. While New Jersey bases its growing water classifications on the total coliform criterion, it does make corresponding fecal coliform determinations for each sampling station, these data are viewed as adjunct information and are not directly used for classification. The State Shellfish Control Authority also has the option of choosing one of the two water monitoring sampling strategies for each growing area.

The Adverse Pollution Condition Strategy requires that a minimum of five samples be collected each year under conditions that have historically resulted in elevated coliforms in the particular growing area. The results must be evaluated by adding the individual station sample results to the preexisting bacteriological sampling results to constitute a data set of at least 15 samples for each station. The adverse pollution conditions usually are related to tide, and rainfall, but could be from a point source of pollution or variation could occur during a specific time of the year. Under this strategy, for *Approved* waters, the total coliform median or geometric mean MPN of the water shall not exceed 70 per 100 mL and not more than 10 percent of the samples exceed an MPN of 330 per 100 mL for the 3-tube decimal dilution test. For *Special Restricted* waters, the total coliform median or geometric mean MPN of the water shall not exceed 700 per 100 mL and not more than 10 percent of the samples exceed an MPN of 3300 per 100 mL for the 3-tube decimal dilution test. Areas to be Approved under the Seasonal classification must be sampled and meet the criterion during the time of the year that it is approved for the harvest of shellfish.

The Systematic Random Sampling strategy requires that a random sampling plan be in place before field sampling begins and can only be used in areas that are not affected by point sources of contamination. A minimum of six samples per station are to be collected each year and added to database to obtain a sample size of 30 for statistical analysis. The bacteriological quality of every sampling station in *Approved* areas shall have a total coliform median or geometric mean MPN not exceeding 70 per 100 mL and the estimated 90th percentile shall not exceed an MPN of 330 per 100 mL. For *Special Restricted* areas, the bacteriological quality shall not exceed a total coliform median or geometric mean MPN of 700 per 100 mL and the estimated 90th percentile shall not exceed an MPN of 3,300 per 100 mL.

This growing area is currently sampled using the Systematic Random Sampling Strategy described above. It was previously sampled using the Adverse Pollution Condition Strategy. The adverse condition was rainfall priority.

## **MARINE BIOTOXINS**

The Department collects samples at regular intervals throughout the summer to determine the occurrence of marine biotoxins. This data is evaluated weekly by the Bureau of Marine Water Monitoring in accordance with the NSSP requirements. An annual report is compiled by the Bureau of Freshwater and Biological Monitoring.

## ***SHORELINE SURVEY***

### **EVALUATION OF BIOLOGICAL RESOURCES**

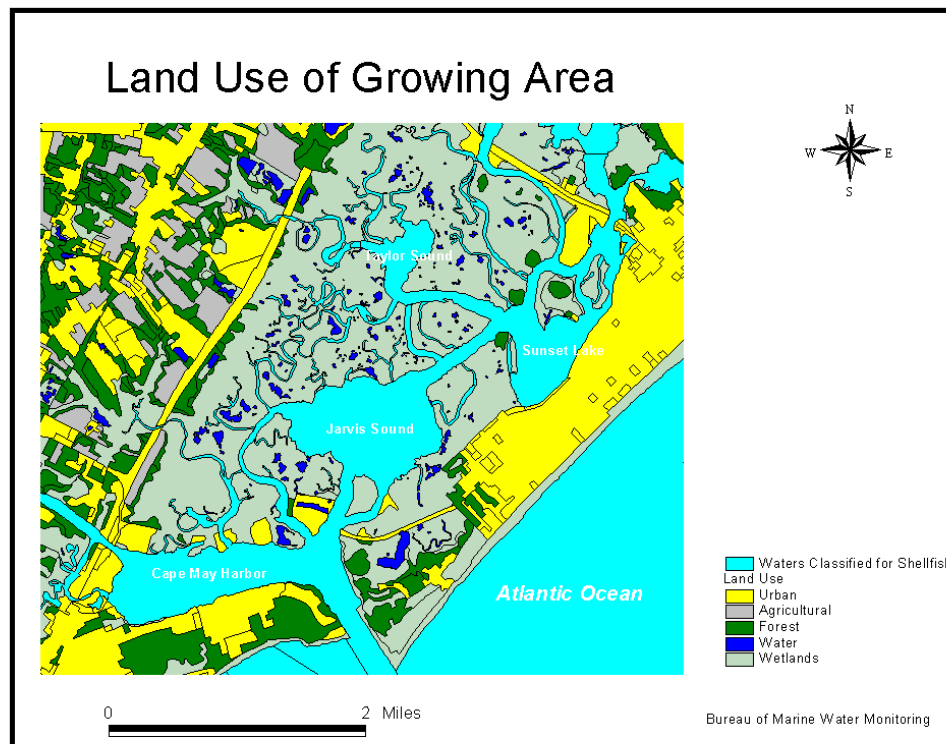
The commercially significant shellfish species in this area is limited to hard clams (*Mercenaria mercenaria*). According to a survey completed by The U.S. Department of the Interior, Fish, and Wildlife Services - 1963, the distribution of hard clams in this area is considered to be in densities of high commercial value.

There is visual evidence of eelgrass growing amongst abandoned piles at the southern end of Sunset Lake (Louisville Avenue).

### **LAND USE**

Extensively developed communities of Wildwood, Wildwood Crest and Cape May City along its eastern boundary characterize this growing area. During the summer season the population increases from less than 15,000 to greater than 400,000. The western boundary of the area is the Garden State Parkway, which acts as a buffer and restricts potential pollutant inputs from any small amounts of pollution crossing over from the smaller communities of Erma, Erma Creek, and Cold Springs. These communities are located along Route 9, which is approximately 1 mile west of the Parkway. There is little or no livestock farming in this area.

**Figure 6: Growing area's Land Use**



There are four small creeks that cross the Parkway and enter the waters of this area. These creeks are Taylor Creek, Jones Creek, Warren Creek and Mill Creek. The shellfish growing waters of this area are located in the back bays, which are surrounded by either tidal marshes (western edge) or a highly developed shoreline (eastern edge).

### **CHANGES SINCE LAST SURVEY**

In the last Sanitary Survey (1994) (Sanitary Survey- Shellfish Growing Area SE-6 Cape May Harbor and Jarvis Sound 1989-1993.) it is stated that the communities of Erma, Erma Creek and Cold Springs Village were still not sewered. Since that time sections of these communities have been sewered.

At the northern end of Sunset Lake (Lake Road and Leaming Avenue), there is extensive new bulkheading that extends for a few blocks south. From the northern tip of Sunset Lake (Lake Road & Rio Grande Boulevard) south along the shore (Park Boulevard) the area is entirely bulkheaded. At the beginning of New Jersey Avenue (along the shore) there is no bulkheading until one comes to the southern most tip of Sunset Lake where there are new pilings and bulkheading. These pilings are located next to the Mariner Inn, which is listed as “for sale” as a future site of a possible marina or mooring area.

From this area south to Cape May Harbor (along Railroad Avenue and Ocean Drive) there is minimal bulkheading along the shore.

### **IDENTIFICATION AND EVALUATION OF SOURCES**

#### **Stormwater**

For the most part stormwater runoff from Wildwood City, Wildwood Crest, and Cape May City is diverted through storm drains into the Atlantic Ocean and the back bays. Up until 1990 these three communities chlorinated storm drains during the summer season. However, this practice is no longer permitted.

From the northern end of Sunset Lake (Hand Avenue) to Rambler Road there are storm drains or scuppers at the end of each street from which stormwater discharges into Sunset Lake. From this point south along the shore of Sunset Lake there are storm drains at the following locations: New Jersey Avenue and Stockton Avenue, New Jersey Avenue and Stanton Avenue, New Jersey Avenue and Faragut Avenue, and New Jersey Avenue and Miami Avenue. There are few storm drains emptying into Jarvis Sound.

#### **Domestic Sewage Treatment**

There are three sewage treatment plants servicing the communities adjacent to this area. Wildwood Lower Regional Wastewater Treatment Facility is located on Route 47 at the site of the former Menhaden Fish Processing Plant. This plant was completed and went on-line in May 1988. This plant has a design capacity of 14.18 MGD. Since the completion of this plant there are no longer any direct discharges of domestic effluent into

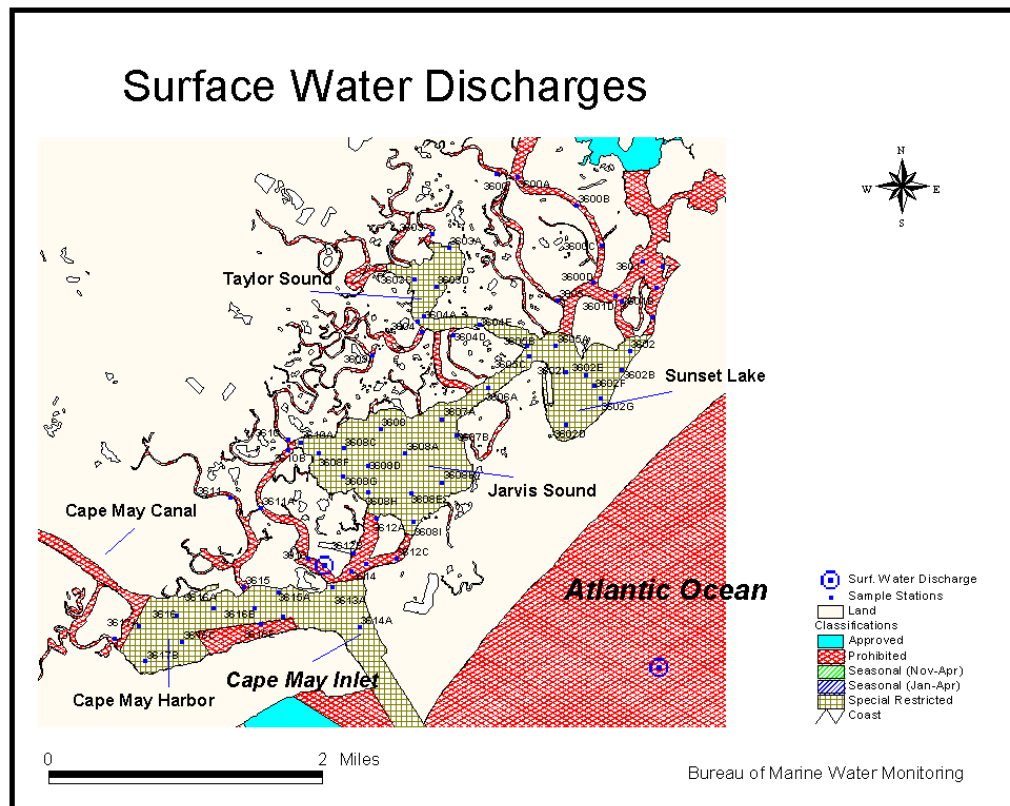
the growing waters of this area. Lower Township Wastewater Treatment Plant (with a capacity of 4.0 MGD) is located at 2900 Bayshore Road in the Villas. Cape May Regional Wastewater Treatment Facility (with a capacity of 3.0 MGD) is located at Cape May Point. The three sewage treatment plants combine the effluent and discharge through the Jefferson Avenue Ocean outfall in Wildwood Crest. The combined design capacity for the three plants is 21.18 MGD.

There are three large campgrounds south of Route 47 that are connected to a sanitary sewer line. The Coast Guard Training Center used to have a problem with a large volume pumping station that was used to remove sanitary wastes from ship. However, in the last Sanitary Survey it was reported that they were connected to the Cape May County Municipal Utility Authority collector line.

There are five pump stations that are located in this growing area. The five pump stations are the following: Shawcrest Pump Station, Rosemary Road Pump Station, Stanton Avenue Pump Station, Madison Avenue Pump Station and Claghorn Place Pump Station.

### Industrial

**Figure 7: Growing Area's Industrial Discharges**

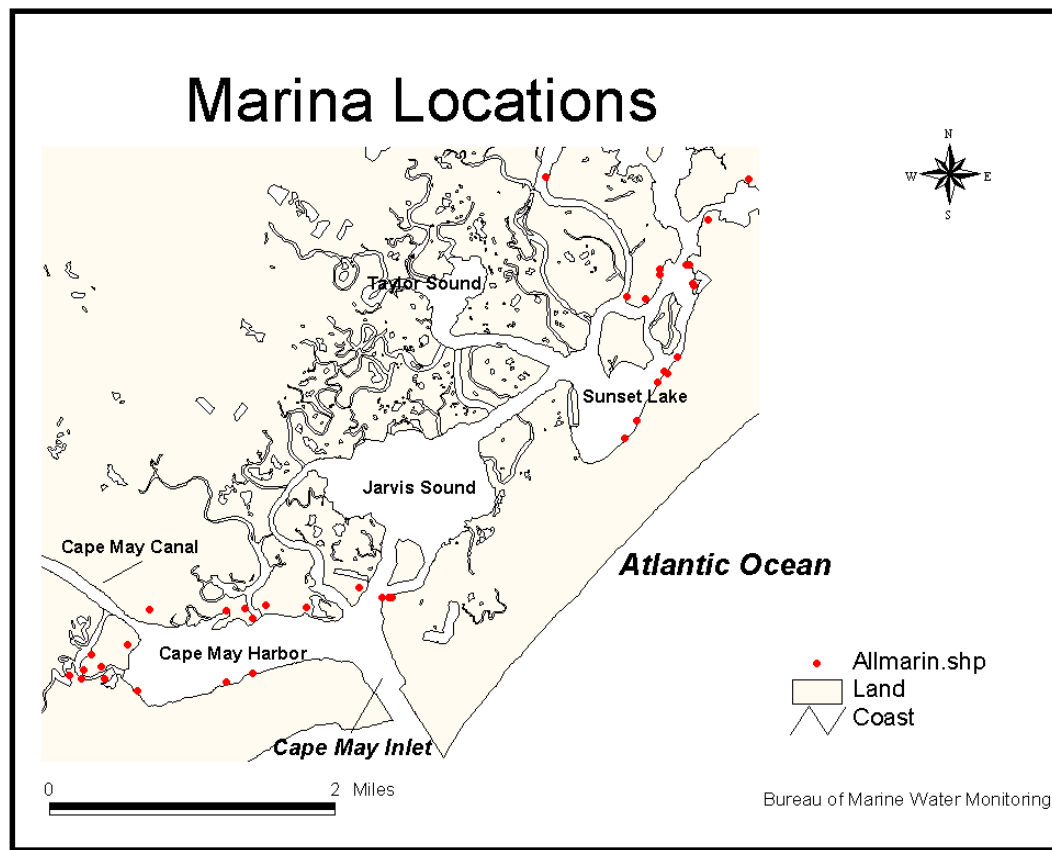


discharges into the area, both from Borden's Seafood Processing Plant (permit # NJ0004961)(see Figure 7). However, after consistently violating their permit specifications by exceeding their effluent limits they were required to hook into Lower Township Wastewater Treatment Facility on April 1, 1992. This facility then processed the waste to Cape May Regional Wastewater Treatment Facility who then discharges through the Jefferson Avenue Ocean outfall in Wildwood Crest. The discharge consists of processing waste only. The plant has since changed hands and is now owned by Snow/Doxie.

## Marinas

Marina facilities have the potential to affect the suitability of shellfish growing areas for the harvest of shellfish. The biological and chemical contamination associated with marina facilities may be of public health significance. New Jersey defines a marina as "any structure (docks, piers, bulkheads, floating docks, etc.) that supports five or more boats, built on or near the water, which is utilized for docking, storing, or otherwise mooring

**Figure 8: Marina Locations**



vessels and usually but not necessarily provides services to vessels such as repairing, fueling, security or other related activities" and designates the confines of the marina as *Prohibited* for the harvest of shellfish. Adjacent waters are classified using a dilution analysis formula.

It is recognized by the National Shellfish Sanitation Program, Manual of Operations, Part1, Section C-9, that there are significant regional differences in all factors that affect marina pollutant loading. The manual therefore allows each state latitude in applying specified occupancy and discharge rates. The NSSP guidelines assume the worst case scenario for each factor.

**Equation 1: Marina Buffer Equation.** (adapted from FDA. 1989, State of Delaware; State of Virginia):

$$BufferRadius(ft) = \sqrt{\frac{2 \times 10^9 (FC / person / day) \times 2 (person / boat) \times [(0.25 \text{ slips} \geq 24') + (0.065 \times \text{slips} < 24')] \times 2}{140000 (FC / M^3) \times depth(ft) \times 0.3048 (M / ft) \times \pi \times 2 (tides / day)}} \times 3.28 (ft / M)$$

Explanation of terms in equation:

Fecal coliform per person per day:	$2 \times 10^9$
Number of people per boat:	2
For slips able to accommodate boats > 24 feet (combination of factors yields multiplier of 0.25):	
Number of slips occupied:	50%
Number of boats occupied:	50%
For boats < 24':	6.5% discharge waste
Angle of shoreline:	180°, which results in factor of 2
Number of tides per day:	2
Depth in meters:	depth in feet x conversion factor
Water quality to be achieved:	140000 FC/meter <sup>3</sup>
Convert meters to feet:	3.28

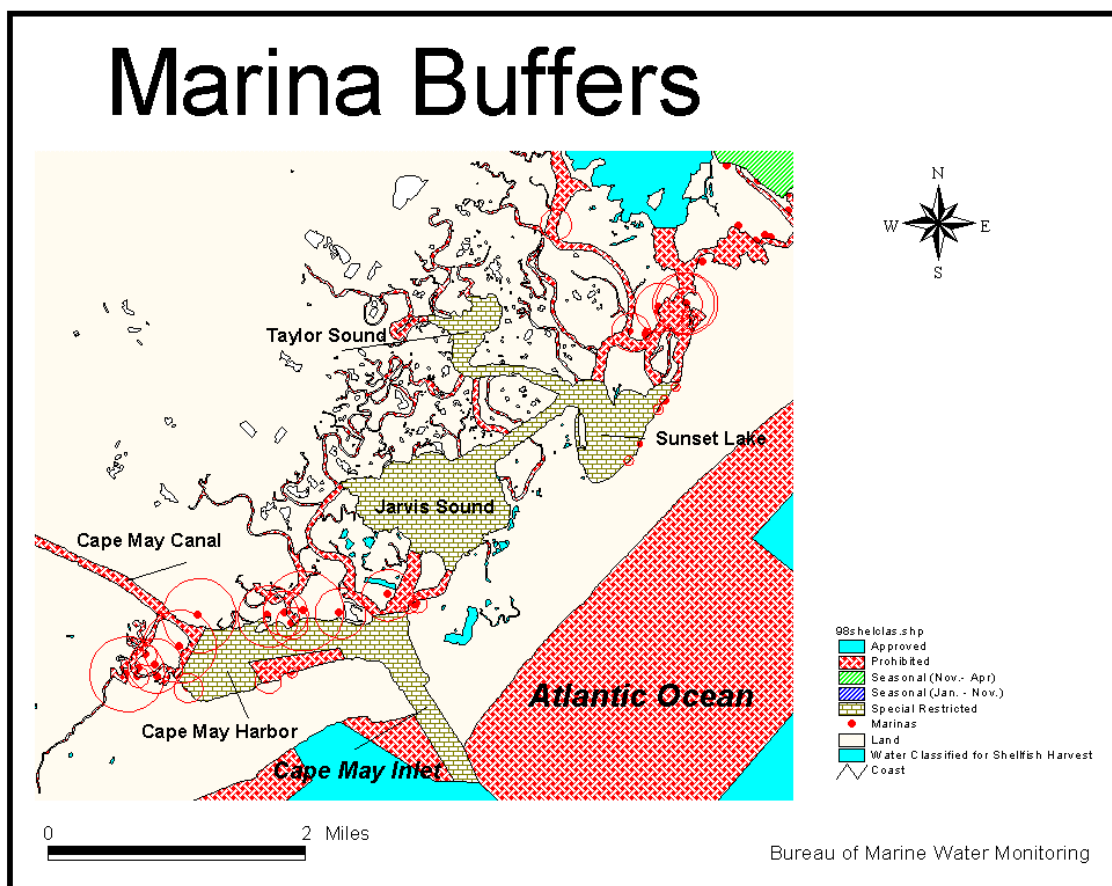
Marina buffer zones may be calculated using the formula above, or may be determined using a dilution analysis computer program developed by the State of Virginia and the USFDA. The computer program is used for complex configurations where the formula is unlikely to provide the needed accuracy.

The area surrounding Cape May Harbor is a major hub for recreational fishing and commercial boating activities. South Jersey's commercial fishing fleet is located here as well as a Seafood Processing Plant. The base of operations for the U.S. Coast Guard

Training Facility is located at Sewell Point. A listing of the marinas (see Figure 8) that are located in this growing area and the seafood processing plant (see Figure 7) can be found in Table 2 and shown in Figure 7 and 8.

In this growing area there are 31 marinas as shown in Table 2 and Figure 8. The waters enclosed by the marina also known as the marina basin are classified as *Prohibited*. The waters immediately adjacent to a marina can be classified as *Prohibited*, *Special Restricted* or *Seasonally Approved* depending on the size of the marina, water quality, flushing rates and the depth of the water. Marina buffer zones were calculated using the formula above. If a marina has no slips that can handle a boat 24-ft or larger then an assumption of 6% failure is established (see Figure 9).

**Figure 9: Growing Area's Marina Buffers**



**Table 2: Listing of the Marina's and Seafood Processing Plant**

MARINA NAME	MUNICIPALITY	ADDRESS	PHONE NO	WET SLIPS TOT/>24 ft	BUFFER (ft.)	PUMP-OUT	DEPTH
Condo Homes w/ slips	Wildwood	Lake & Hildreth		18		No	3 ft
Pier 47 Marina	Wildwood	Wildwood Blvd..	729-4774	80/6	636	No	5 ft
Sea Raider Charter Boats	Wildwood	Rio Grande Blvd.	522-1032	7/7	265	No	8 ft.
M-Ocean	Wildwood	Rio Grande blvd.	522-3017	12/12	347	No	8 ft.
Royal Flush Fleet (Party Boats)	Wildwood Crest	Park & Aster Ave	522-0177	3/3	174	No	8 ft.
Greater Wildwood Yacht Club	Wildwood	New Jersey & Stanton Ave.	522-0969	16/0	193	No	9 ft.
Greater Wildwood Yacht Club	Wildwood	Park & Forget me not	729-0309	14/0	204	No	7 ft.
Sunset Lake Marina	Wildwood	Park & Wisteria	522-3309	0/0 Rentals	-----	No	7 ft (high)
Captain Sinns Marine Center	Wildwood	Park & Aster	523-8989	3/3 (not used Ind.-covered by 1 party boat)	174	No	8 ft.
Lake View Docks (boat rentals)	Wildwood Crest	Rambler & NJ Ave		4/0 boat lift	102	No	8 ft.
Lighthouse Point Marina	Lower Twp.	Shawcrest Island	729-5155	165/165	1010	Yes	13 ft.
Starcrest Marina	Lower Twp.	Shawcrest Ave. & Crocus	522-2775	10/1	211	No	6 ft.
Breezee Lee Yacht Club	Cape May City	900 Ocean Drive	884-4849	200 /20	1035	No	4-5(low)
Mill Creek Marina	Lower Twp.	Ocean Drive	884-4391	100/100	1636	No	3 ft.
South Jersey Marina	Lower Twp.	U.S. Hwy. Rt. 109	884 -177	63/60	1105	No	3-4 ft
Roseman's Boat Yard	Cape May City	Roseman's Lane	884 -370	20/5	423	No	4 ft(low)/7 ft (high)
Cape May Marina	Cape May City	Layfeyette Ave.	884 -262	165/140	1534	No	5 ft
Utsch's Marina	Lower Twp.	2332 U.S. Hwy. Rt. 109	884-2051	250/250	1493	No	9 ft.
Hinch's Marina	Lower Twp.	989 Ocean drive	884 -289	110 /110	1051	No	8 ft.
Cape Harbor Yacht Club	Cape May City	Ocean Drive		25/25	366	No	15 ft.
McDuells Marina	Cape may City	Ocean drive	884-0404	25/20	925	No	2 ft.
Harbor View Marina	Cape May City	Ocean drive	884-0808	25/20 boat lift	654	No	4 ft.
Cedar Creek Marina	Cape May City	Ocean Drive	884-4217	65/30	1253	No	2 ft.

MARINA NAME	MUNICIPALITY	ADDRESS	PHONE NO	WET SLIPS TOT/>24 ft	BUFFER (ft.)	PUMP-OUT	DEPTH
Canyon Club Resort Marina	Cape May City	900 Ocean Drive	884-0188	257/257	1514	Yes	9 ft.
Corinthian Yacht Club (sailboat moorings)	CapeMay City	Delaware Ave. (640)		18/18	538	No	5 ft.
Harbor Village & Yacht Club	Cape May City	Pittsburgh Ave.	884-5800	26/26	590	No	6 ft.
U. S. Coast Guard	Cape May City	Delaware Ave. (640)	884-6975	8/8 large defense vessels	200		16 ft.
Two Mile Landing Rest. & Marina	Lower Twp.	Ocean Drive	522-1341	24/24	358	No	15 ft.
Miss Chris Fishing Center	Cape May City	Wilson Drive	884-5445	11/11	420	No	5 ft.
Tony's Marine Railway	Cape May City	Schellenger's Lane	884-8781	0/0	----	No	5 ft.
Yacht Lodge Marina	Cape may City	Yacht Avenue	884-5224	12/12	371	No	7 ft.
Snow/Doxie Seafood Processing Plant	Lower Twp.	Ocean Drive					
Commercial Center	Lower Twp.	Ocean Drive	522-1341	5/5 Large commercial vessels	5/5	No	15 ft.

## ***HYDROGRAPHY AND METEOROLOGY***

This growing area is bordered by an extensively developed shoreline to the east and south and bordered by tidal wetlands to the west and north. These wetlands act as a buffer for the communities from the western side of the state. The area consists of four main water bodies, Taylor Sound, Sunset Lake, Jarvis Sound and Cape May Harbor. The back bay waters have depths ranging from 1 to 18 feet (MLW). The depths of Lower, Middle and Upper Thorofare range from 2 to 20 feet and the depth of the Intercoastal Waterway average 15 to 20 feet. There is an average range of 3 feet in this area for the diurnal (twice/day) tides. Tidal flushing of the area occurs mainly through the Cape May Inlet with some dilution through the Cape May Canal.

Precipitation inputs to the area for the period 1992 through 1998 are shown in Table 3. There have been no significant changes in hydrography since the re-evaluation completed in 1996. The primary weather station for this area is Cape May. The secondary weather station for this area is Millville. The secondary station data is used when data from the primary station are incomplete.

**Table 3: Climatological Data** (Rainfall Recorded at NOAA's Cape May Station at 1200 hrs; Wind and Temperature aboard sampling vessel at time of sample collection)

Sampling Date	Precipitation in Inches				Wind		Temp °C
	Sampling day	1 day prior	2 days prior	3 days prior	Wind Dir.	Wind Vel.	
02/03/92	0.000	0.000	0.000	0.000	-----	-----	-----
04/21/92	0.000	0.000	0.270	0.640	-----	-----	-----
07/14/92	0.120	0.120	0.270	0.640	180	2	30.0
08/07/92	0.000	0.000	0.000	0.590	180	8	22.0
09/08/92	0.020	0.050	0.270	0.270	120	2	23.0
06/02/93	0.040	0.580	0.800	0.800	120	4	18.0
07/16/93	0.000	0.090	3.040	3.040	330	8	23.0
09/02/93	0.000	0.000	0.000	0.000	180	2	24.0
10/22/93	0.590	1.670	1.740	1.740	330	12	16.0
03/31/94	-----	-----	-----	-----	-----	-----	-----
05/25/94	-----	-----	-----	-----	-----	-----	-----
06/16/94	-----	-----	-----	-----	-----	-----	-----
07/14/94	-----	-----	-----	-----	-----	-----	-----
09/28/94	-----	-----	-----	-----	-----	-----	-----
11/30/94	-----	-----	-----	-----	-----	-----	-----
05/03/95	0.000	0.850	0.850	1.230	300	8	12.0
07/06/95	0.120	0.120	0.120	0.120	180	8	21.0
08/01/95	0.000	0.000	0.000	0.000	180	8	24.0
08/02/95	-----	-----	-----	-----	185	3	22.0
09/26/95	0.290	0.690	0.690	0.710	40	10	19.2
10/12/95	0.000	0.000	0.000	0.000	40	2	21.0
10/26/95	0.000	0.000	0.000	0.000	40	2	19.0
02/27/96	0.000	0.010	0.010	0.040	40	4	12.0
05/30/96	0.000	0.250	0.570	0.790	320	12	12.0
06/24/96	0.270	0.270	0.270	0.320	180	4	21.0
07/25/96	0.000	0.000	0.010	0.040	180	10	23.0
09/17/96	1.000	2.040	2.040	2.040	40	2	21.0
10/10/96	0.120	0.420	2.590	2.590	180	4	15.0
09/09/97	0.000	0.000	0.010	0.010	85	12	19.0
03/25/98	0.000	0.000	0.000	0.150	120	4	8.0
03/31/98	0.000	0.000	0.000	0.000	200	12	13.0
04/29/98	0.000	0.000	0.000	0.000	180	10	12.0
05/13/98	0.000	0.000	0.000	0.000	10	12	14.0
05/27/98	0.000	0.000	0.000	0.000	300	2	18.0
06/12/98	0.000	0.000	0.000	0.000	120	10	18.0

## ***WATER QUALITY STUDIES***

### **BACTERIOLOGICAL QUALITY**

The raw data listings and statistical summaries in accordance to National Shellfish Sanitation Program (NSSP) criteria are given in the Appendix. There were no stations that exceeded the NSSP criteria applicable to the classification of each area.

## ***INTERPRETATION AND DISCUSSION OF DATA***

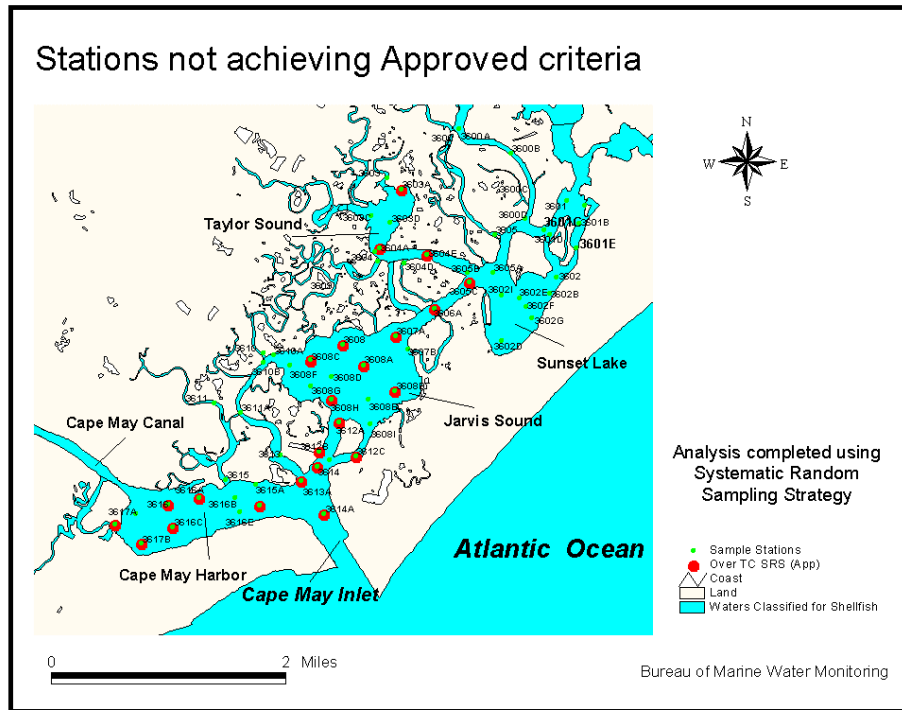
### **BACTERIOLOGICAL**

Criteria for bacterial acceptability of shellfish growing waters are provided in Guide for the Control of Molluscan Shellfish, Part IV, Shellstock Growing Areas (USPHS, 1997 revision). Each state must adopt either the total coliform criteria or the fecal coliform criteria for growing water classifications. Historically, New Jersey has based growing water classifications on the total coliform criteria and continues to use the total coliform criteria.

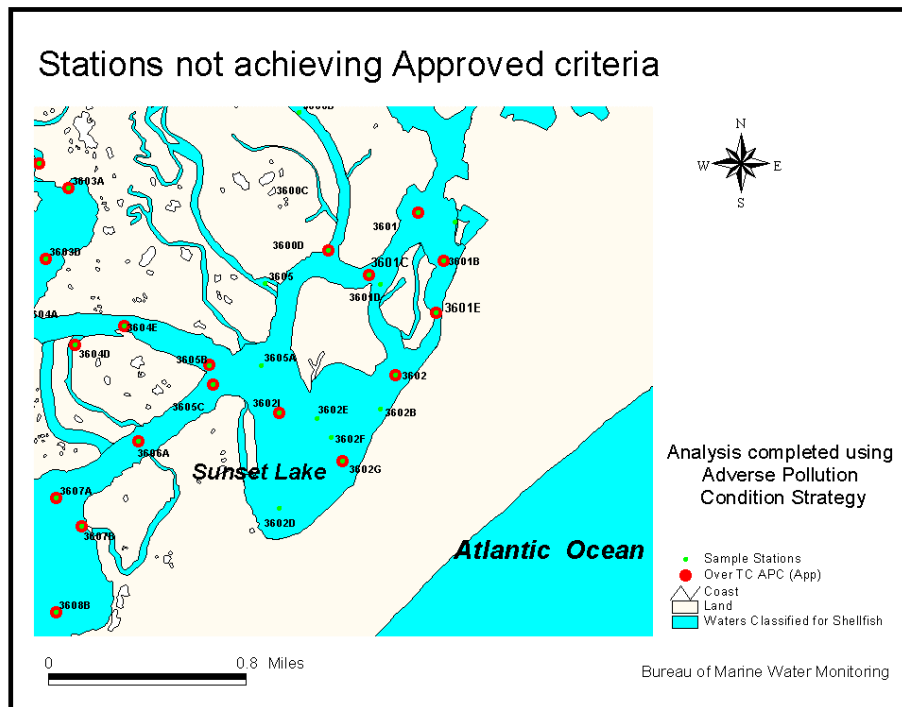
The total coliform standard needn't be applied if it can be shown by detailed study verified by laboratory findings that the coliform are not of direct fecal origin and do not indicate a public health hazard. While New Jersey does make corresponding fecal determinations for each total coliform determination, this data is viewed as adjunct information and is not directly used for classification. Therefore, the data analysis is based on the total coliform results in which the total coliform median or geometric mean MPN for *Approved* classification does not exceed 70/100 mL and not more than 10% of the samples exceed an MPN of 330/100 mL, where the three tube decimal dilution test is used. And for areas classified as *Special Restricted*, the total coliform median or geometric mean MPN of the waters does not exceed 700/100 mL and not more than 10% of the samples exceed the MPN of 3300 per 100 mL.

A total of 1549 water samples from 69 stations in this growing area were analyzed by the Bureau of Marine Water Monitoring's laboratory at Leeds Point for total coliform (TC) and fecal coliform (FC) bacteria for the period of 1-1-92 to 6-12-98. See Figure 2 for sampling station locations. This water quality data was evaluated using the criteria applicable to the Systematic Random Sampling Strategy, which requires 30 sets of data. However, due to changes in the sampling schedules, insufficient data was available to evaluate water quality in Sunset Lake without using data prior to the construction of the

**Figure 10: Stations not achieving *Approved* criteria by SRS Strategy**



**Figure 11: Stations located in Sunset Lake not achieving *Approved* criteria by APC Strategy**



Wildwood Lower Regional Wastewater Treatment Facility. Therefore, the Sunset Lake data was evaluated separately using the criteria for Adverse Pollution Conditions, which require only 15 data sets. See figure 10 for stations not achieving *Approved* criteria after being evaluated by Systematic Random Sampling Strategy and see figure 11 for stations located in Sunset Lake not achieving *Approved* criteria after being evaluated by Adverse Pollution Condition Strategy. See Appendix for the listing of lowest median and highest values plus the percentage greater than the allowable criteria for *Special Restricted* water.

Tidal impacts were evaluated by performing a t-test on log - transformed total coliform MPN values. After evaluation, there was no significant tidal component found in the water quality. Since there were no stations that exhibited strong tidal effects, this area is not sampled on either an ebb tide or flood tide priority.

Seasonal effects were assessed using a t-test to compare log-transformed total coliform values for summer versus winter data. After evaluation, there was no significant correlation between total coliform MPN and season. It should be noted that there was one station that did exhibit a correlation with season. This station was 3601C with a t-probability of 0.02206 however, there was only fifteen sets of data and considering that this station is in an area that is being evaluated by Systematic Random Sampling this station is invalid since thirty sets of data are needed for evaluation.

Rainfall impacts would be assessed using correlation analysis of total coliform MPN values versus cumulative rainfall on the day of sampling, one day prior to sampling, and two days prior to sampling. However, since this area was sampled under Adverse Pollution Condition strategy-rainfall priority- a correlation cannot be determined. The statistical test is invalid when the area is collected under rainfall priority. (Appendix I).

## **NUTRIENTS**

There are six stations located in this area that are sampled under the estuarine monitoring program for key chemical parameters. These six stations are 3602D, 3607A, 3614A, 3616B, 3617A, and 3618. During the time period of 1990 to 1993 the stations located in Cape May Harbor had compatible data with the other stations located throughout the state. The data obtained from the station located in Jarvis Sound was also compatible for most parameters except was higher than the others for fecal coliform were. The station located in Sunset Lake was also compatible for most parameters except during the summer season this station was considered to be biologically stressed versus normal for dissolved oxygen according to NOAA's dissolved oxygen standard. To be considered biologically stressed the value of dissolved oxygen must be below 5.0 mg/L (actual value was 4.5 mg/L). This station exhibited high ammonia levels during the summer season compared to other stations throughout the state. The actual value was 238.5 µg N/L whereas the average value for the category shallow estuaries was 78.00 µg N/L (see Table 5). Table 5 lists the average and maximum values for each parameter at each station over

the course of the sampling period of 1990-1993. For individual values and other areas of question, please refer to Report on Marine and Coastal Water Quality, 1990-1993.

**Table 4: Nutrient Parameters**

STATION		TEMP (° C) AVG/MAX	SALINITY (PPT) AVG/MAX	SECCI (METERS) AVG/MAX	TSS (MG/L) AVG/MAX
3602D		15.80/24.00	31.15/32.92	2.38/3.00	38.77/60.40
3607A		13.60/22.00	31.40/33.73	4.00/6.00	39.46/53.33
3614A		13.20/23.00	31.36/32.12	3.80/5.00	41.31/65.67
3616B		15.13/22.00	30.55/31.09	2.63/4.00	36.38/52.33
3617A		12.90/21.00	30.60/31.18	2.60/4.00	42.78/71.20
3618		17.67/22.00	30.28/30.78	2.67/3.50	42.77/67.60
STATION	DO (mg/L) AVG/MAX	NH3 (µgN/L) AVG/MAX	NO3 (µgN/L) AVG/MAX	TON (µgN/L) AVG/MAX	PO4 (µgP/L) AVG/MAX
3602D	7.58/10.80	96.33/238.50	13.23/25.50	244.63/322.90	15.90/22.70
3607A	8.46/10.70	65.66/129.80	8.22/23.60	216.06/326.10	20.20/40.20
3614A	8.62/11.10	60.70/114.20	25.32/79.70	224.04/426.80	20.24/37.20
3616B	6.43/10.95	79.25/140.20	24.15/51.90	298.80/420.40	25.33/40.50
3617A	8.64/11.85	100.10/255.00	21.04/54.70	291.46/442.90	22.70/41.70
3618	7.22/8.25	104.83/157.10	31.47/65.80	364.43/458.60	31.40/33.90

## ***CONCLUSIONS***

### **BACTERIOLOGICAL EVALUATION**

Water quality in this area has in general not been as good as expected since the 1996 reevaluation of the area and the 1997 annual report. Both of these reports had indicated that water quality was appearing to become better. However, all the stations in this area still remain in compliance with the current classifications of *Special Restricted* and *Prohibited*.

This area was evaluated using both Systematic Random Sampling and Adverse Pollution Condition Strategies. Sunset Lake was evaluated by Adverse Pollution Condition strategy and the remaining area was evaluated using Systematic Random Sampling strategy. Sunset Lake - a major water body in this area - had very little data. As discussed before, Sunset Lake was dropped from the sampling schedule due to budget restraints in 1993. It was placed back on the schedule again for the 1995-1996 sampling year after a request from the Atlantic Coast Shellfish Council to evaluate the water quality and the potential for an upgrade. Since Sunset Lake was not on the sampling schedule during those years, there were only fifteen sets of data for evaluation. Therefore, Sunset Lake was evaluated by Adverse Pollution Condition Strategy. If Sunset Lake was evaluated by Systematic Random Sampling Strategy then a retrieval dated back to 1989 would have had to been done in order to obtain thirty sets of data. Since 1989 was only one year after the Wildwood Regional Sewage Treatment plant went on line, it would not have been representative of current water quality.

When Sunset Lake was evaluated it showed that out of the four stations that are currently being sampled (3602, 3602D, 3602G and 3602I) three did not meet the *Approved* criteria (3602, 3602G, and 3602I). It is unclear as to why stations 3602G and 3602I do not meet this criteria. Station 3602G is down and offshore from any marina and the closest marina is only for small rental boats. A marina of this size or caliber would normally not exhibit such an effect on a station. Station 3602I also is a mystery as to why it does not meet the *Approved* criteria. This station is in the middle of Sunset Lake with no apparent contributing factors. As stated before, there is no tidal, seasonal, or rainfall correlation with any of the stations. Selected stations were analyzed individually and it was determined that there were no trends that could be established for this time period.

The remaining stations in this area were evaluated by Systematic Random Sampling strategy and continue to meet the criteria for *Special Restricted* classification. Although all the stations meet the criteria for *Special Restricted* classification, there are sections that will remain classified as *Prohibited*. This is due to the large number of marinas in the area of these stations. The marinas and their associated boating activities are a potential source of contamination. According to N.J.A.C. 7:12-2.1(a)ii which states that “. . . shellfish growing waters are classified *Prohibited*” in “all marinas, anchorage’s or other places where docking or mooring facilities are provided for boats”.

Jarvis Sound, which is another major water body in this area, was analyzed using Systematic Random Sampling strategy. Stations located in Jarvis Sound continue to exceed the criteria for *Approved* classification. Tide, season or rainfall does not affect the stations. This area is mainly surrounded by tidal marshes with little development. There are no obvious sources of bacterial contamination. Five stations have been established for coliphage sampling, but no data is available at this time.

## ***RECOMMENDATIONS***

### **BACTERIOLOGICAL EVALUATION**

It is recommended that the number of runs be increased from 6 to 15 for sampling year 1998-1999. This will allow a greater amount of recent data to make an evaluation since data evaluated in this report dates back to 1992. This also will allow Sunset Lake to be analyzed using Systematic Random Sampling strategy since more than fifteen sets of data will be obtained.

It is recommended that stations 3602B, 3602C, 3602H, and 3602J in Sunset Lake be reestablished for sampling. There are no seasonal, tidal or rainfall effects on the stations located in Sunset Lake but these stations continue to fail the criteria for *Approved* classification. Therefore it is also recommended that coliphage sampling be established at the following stations: 3602B, 3602C, 3602G, 3602H, and 3602I. These stations should be sampled for coliphage alternately with the stations previously designated for coliphage sampling in Jarvis Sound.

It is recommended that, due to the size of the marina buffers that were established in Cape May Harbor, this area continue to be off-limits to shellfish harvesting. The buffers encompass most of Cape May Harbor. Rather than downgrading the classification of this area to *Prohibited*, limiting shellfish harvest provides administrative flexibility in the event that marinas close or the size of the buffer decreases.

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## ***APPENDICES***

### A. Statistical Summaries

Yearround

Winter Only

Summer Only

### B. Seasonal Evaluation

### C. Precipitation

Rainfall Correlation

Cumulative Rainfall

Wet Weather Statistical Summary

Dry Weather Statistical Summary

### D. Tidal Evaluation

### E. Data Listing - 1992 through 1998

NOTE: APPENDICES ARE NOT AVAILABLE ON THE WEB SITE